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VIRGINIA RECREATIONAL FISHING DEVELOPMENT FUND PROJECT APPLICATION

NAME AND ADDRESS OF APPLICANT Virginia Institute of Marine Science P.O. Box 1346 Gloucester Point, VA 23062-1346	**PRINCIPAL INVESTIGATORS** Robert J. Orth
PRIORITY AREA ADDRESSED HABITAT RESTORATION AND EDUCATION	**PROJECT LOCATION** VIMS

DESCRIPTIVE TITLE OF PROJECT

Restoration of Submerged Aquatic Vegetation (SAV) Habitat in Chesapeake Bay and the Virginia Coastal Bays

PROJECT SUMMARY

Seagrasses, one of the most valuable habitats in the world, remain absent or sparse in many areas of the Chesapeake Bay and its tributaries and the Virginia Coastal Bays. The goal of the seagrass restoration program is to establish seagrass in areas that formerly supported this habitat and especially in areas that are important for recreational fishing. The objectives of our 2009/10 work are to build on previous years successes by completing the following: 1. Continue seagrass restoration in areas that are suitable for large scale plantings using seeds, targeting areas in the James River and the seaside coastal lagoons, 2. Conduct experiments that optimize growth and spread of seagrass in transplanted areas and 2. Monitor success of previously planted areas; and 4. work collaboratively with Chesapeake Bay conservancy (e.g. TNC) and state management groups (e.g.,VMRC) to assist in baywide SAV restoration efforts.

EXPECTED BENEFITS

Restoration of seagrass habitat to areas that once supported these productive communities will provide additional foraging areas for several species of recreationally important finfish species (e.g. speckled trout, striped bass, red drum), and their preferred food items, especially species such as juvenile blue crabs.

COSTS

June, 1, 2009, through May 31, 2010

VMRC Funding:	$ 98,309
VIMS Funding:	$ 13,297
Total Cost	$ 111,606

detailed budget included with proposal

VMRC Saltwater Fishing License Development Fund:
Restoring SAV Habitat
June 1, 2009 - May 31, 2010

PERSONAL SERVICES	MRFAB	VIMS
Marine Scientist (7 mo)	35,672	
Laboratory Technician (7 mo)	18,289	
Fringe Benefits (35% of salaries)	18,886	
OPERATIONS		
Travel Field Sites (VIMS vehicle rental @ .58/mi)	1,900	
Supplies (Field and lab supplies incl. dive gear, pvc, cores, forceps, trays, etc.)	1,900	
Vessel Rental	2,000	
Indirect Cost (25% MRFAB Support) (43% VIMS Rate)	19,662	13,297
TOTAL	$98,309	$13,297

Proposal Submission to

The Virginia Marine Resources Commission
Virginia Recreational Fishing Development Fund

By

The Virginia Institute of Marine Science
College of William and Mary

Restoration of Submerged Aquatic Vegetation (SAV) Habitat
In Chesapeake Bay and the Virginia Coastal Bays

BUDGET PERIOD: June 1, 2009 to May 31, 2010

Robert J Orth

Dr. Robert J. Orth
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RESTORATION OF SUBMERGED AQUATIC VEGETATION (SAV) HABITAT IN CHESAPEAKE BAY AND THE VIRGINIA COASTAL BAYS

A PROPOSAL SUBMITTED TO:

THE VIRGINIA RECREATIONAL FISHING LICENSE DEVELOPMENT FUND

BY

SCHOOL OF MARINE SCIENCE
VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

PRINCIPAL INVESTIGATOR
Robert J. Orth

INTRODUCTION

The value of seagrass beds as nursery areas and as feeding grounds for several species of commercially and recreationally important fish is well established (Peterson, 1918; Thayer, et al., 1984; Orth, et al., 1984; Orth and van Montfrans, 1987; Orth and van Montfrans, 1990). The 1997 blue crab management plan established seagrass beds as one of the most important nursery habitats (Chesapeake Executive Council, 1997). The importance of established seagrass beds in the lower Chesapeake Bay are often cited in newspaper accounts as prime fishing locations for recreationally important species such as speckled trout.

The dramatic decline of submerged aquatic vegetation (SAV) in Chesapeake Bay in the early 1970s resulted in many shallow water areas becoming devoid of any vegetation (Orth and Moore, 1983). A quarter century later, many of these same areas remain either unvegetated or very sparsely vegetated (Orth et al., 2007). A major focus of SAV research in Chesapeake Bay was initially on water quality effects limiting regrowth of SAV (Dennison et al., 1993). However, recent observations in areas experiencing natural revegetation and experiments on the seed dispersal ecology of eelgrass (Orth et al., 1994; 2003) suggests that transplanting efforts may be an important component to restore or enhance seagrass habitat to historic levels.

Our research program in seagrass habitat restoration, currently partially funded by the Virginia Saltwater Recreational License Fund, couples basic factors limiting seagrass recruitment, growth and survival, with the applied aspects of seagrass restoration and the relevance for important recreational species. We are exploring these relationships by using transplanted beds of eelgrass, the dominant species of SAV in the lower Chesapeake Bay, in areas that were historically vegetated prior to 1972, and are presently unvegetated, or very sparsely vegetated, as well as in the seaside coastal lagoons which once supported abundant grassbeds up until 1933. A major goal is to understand factors that limit the re-growth of eelgrass and how restored areas function to support recreational fisheries. In those areas where habitat restoration is successful, we are examining the dynamics of plant colonization, either from vegetative growth or from seeds. Our restoration program has relevance in the overall context of Chesapeake Bay's Executive Council's Directive to restore seagrass beds to their historical distributions (Chesapeake Executive Council, 1989, 1990). Our past proposals have received the endorsement of several bay groups such as the EPA's Chesapeake Bay Program and the Chesapeake Bay Commission.

The overall goal of this long-term project is aimed at addressing several of the priority concerns of the Recreational Fishing Development Fund. Besides improving and enhancing habitat through transplanting adult plants and seeds, we conduct research and gather data to improve the techniques to restore grasses and better understand the roles these beds play for recreational fisheries. This project also supports educational opportunities, primarily with non-profit Chesapeake Bay conservation groups. Many of these groups have learned from our experiences with this project and incorporated such information to their own seagrass restoration efforts to improve their own success rates (e.g. Chesapeake Bay Foundation, Alliance for the Chesapeake Bay, The Nature Conservancy).

IMPORTANT FINDINGS TO DATE

PROJECT GOALS

This project initially had three major goals:

1. Continue efforts at restoring seagrass beds in lower Chesapeake Bay and the Coastal Bays.

2. Assess the most beneficial configuration of transplant plots for assuring plant persistence and spread to insure a maximal forage base for finfish (i.e., highest abundances of shrimps, crabs, and finfish).

3. Continue our partnership with various educational and conservancy groups that are working toward successful SAV restoration.

GOALS 1 and 2: Restoring seagrass beds

1. Large scale seagrass plantings have occurred each year from 1996 through 2008 in either the James, York, Rappahannock or Piankatank rivers, or the seaside coastal bays. Some of these sites continue to grow and spread into surrounding areas, in particular the seaside coastal bays. We have also conducted experiments to determine whether density of seeds affects seed germination. Initial results do not show that seed density is a factor in germination (Orth et al., 2003). In 100 meter^2 seed plots throughout the Bay (each containing 50,000, 100,000 or 200,000 seeds), we have observed that 5-15% of the seeds have germinated to become seedlings. Although this may seem a low percentage, it shows that it is possible to quickly establish several thousand shoots using seeds, whereas transplanting the same number of adult transplants requires several days of SCUBA diving. In 2001, we collected and dispersed over 5.8 million seeds in 1-acre plots covering a total of 41 acres. Seven acres of seeds were dispersed in the lower James River between Peterson's Yacht Basin and Merrimac Shores. While detailed data on percent cover and density of plants are not available at this time, aerial photography of the South Bay area, where seeds were broadcast into 24 acres, revealed the presence of these plots at an altitude of 12,000 ft. Our field observations of these one-acre plots indicated that the spread of plants that developed from the surviving seeds has been far better than we had originally expected. In 2002, we collected and dispersed over 2.4 million seeds in 1-acre plots covering a total of approx. 31 acres. In 2003, we collected and dispersed over 2.6 million seeds in 0.5 -acre plots covering a total of approx. 31 acres. In 2004, we dispersed approximately 10 million seeds in both the spring and fall. The spring broadcast involved placing eelgrass reproductive shoots with seeds in mesh buoyant bags that allowed seeds to mature and drop to the bottom rather than waiting until the fall after seeds were held in running water tanks at VIMS. In 2005 and 2006, we continued the large scale transplanting in the seaside bays as well as Piankatank River, funded by NOAA, the Army Corps of Engineers, and the Nature Conservancy. In 2007, we broadcast approximately 7 million seeds into 40 acres at sites in the James and Rappahannock rivers and the coastal bays. In 2008, we continued our successful efforts in the coastal bays by adding 1.8 million seeds and 1 million seeds to the James and York rivers. By the end of 2008, we have transplanted nearly **200,000 adult plants** and over **45,000,000 seeds** in the lower Chesapeake Bay and seaside bays.

The success at our seaside site is highlighted in Figs. 1-6.

2. We have designed a simple technique for transplanting whole plants that is cost effective, efficient, highly successful, and has less impact on donor beds (Orth, et al., 1999). These plants spread to achieve shoot densities and cover similar to what is observed in natural beds.

3. Planting patterns with adult plants have been designed to address basic questions on the influence of patch size on survival, and the role of seeds vs. vegetative growth in patch growth. The data, to date, appear to show that the patch sizes we have used (4 m^2 to 400 m^2) show no effect of patch size on transplant survival (Orth, et al., 2003).

4. All plots planted with adult plants produced flowers and seeds in the spring of the year following planting and there appears to be no strong effect of patch size and structure on the reproductive ability of eelgrass. Seeded plots produced flowers and seeds during the spring of the second year.

5. Numerous sites around the lower bay had been planted with smaller test plots to determine suitability of the sites for future planting efforts and to better understand the processes controlling survival of the plants, especially those related to water quality.

6. Our seagrass restoration efforts in Virginia's seaside lagoons beginning in 1998 has had unparalleled success to date. We have acquired almost 1200 acres of set aside areas for seagrass restoration from VMRC that protects these areas from other activities, such as clam dredging.

7. We have successfully constructed a prototype seed planter designed after the planter built by the Univ. of Rhode Island that deposit seeds in the sediment. We are currently in the test phase to determine how rates of establishment with the planter compare to simply broadcasting seeds.

<u>GOAL 3—Partnerships with educational groups</u>

VIMS staff have worked successfully in the past with a number of volunteer groups. Many of these groups have initiated SAV restoration programs themselves to varying degrees. We believe a synergistic relationship between VIMS and these other programs will more quickly enhance SAV habitat and increase awareness and education of the importance of grasses. For example, we have worked collaboratively with VMRC staff and volunteers from the Nature Conservancy in a seagrass restoration project along the seaside of the Delmarva Peninsula (South Bay). In 2001, we advised the Alliance for the Chesapeake Bay with transplant methodology and with establishing grow-out areas from which to collect plants for transplantation. From 2000 through 2004 VIMS staff has worked with CBF and Alliance for Chesapeake Bay staff by providing advice to grow eelgrass and wild celery in public middle and high school classrooms. This program has previously been successful growing the freshwater species wild celery (*Vallisneria americana*) in classrooms and planting these into the James River.

In the fall of 2001, we also tested a mechanical transplanting device from Florida. The Chesapeake Bay Foundation hired a machine to transplant an acre of grass in the Rappahannock (at the site of one of the successful VIMS test plots) and in the lower James River. As there has not been a rigorous test of this machine's efficiency compared to existing methods, VIMS staff conducted a side-by-side comparison experiment between machine transplanting and hand transplanting. The results showed that while mechanical planting does plant at a faster rate than hand planting, overall success of mechanically planted plants was low compared to plants placed in the bottom by hand so that there was no significant savings in time success per unit time using a mechanical planter (Fishman, et al., 2004).

PROPOSED 2009-2010 WORK: GOALS

1. Collect and disperse seeds in large areas while conducting additional restoration experiments that optimize growth and spread of seagrass in Virginia waters and monitor the success of previously planted areas.

2. Continue to work collaboratively with Bay conservancy groups, such as the Chesapeake Bay Foundation (CBF), Coastal Conservation Association (CCA), Alliance for Chesapeake Bay (ACB) and Nature Conservancy (NC), as well as other bay state management groups (MD Dept. of Natural Resources) to assist and enhance baywide SAV restoration efforts.

GOAL 1 Large scale restoration efforts and additional experiments.

* Collect and disperse seeds in large areas while conducting additional restoration experiments that optimize growth and spread of seagrass in Virginia waters and monitor the success of previously planted areas.

In 2009, we will continue to emphasize the use of seeds in large-scale restoration efforts with eelgrass. During this year, we will concentrate our efforts in several locations where we have had recent successes. First and foremost we will continue our efforts in the seaside coastal bays where we have been having unparalleled success to date in re-establishing seagrass to areas formally supporting eelgrass in the early 1900s. Second, we will continue to establish large plots in the James and York rivers near existing beds that indicate water quality is adequate to support eelgrass over the long term.

Our previous work with harvesting seeds has shown that there is generally a 3-4 week window to harvest mature reproductive shoots with ripe seeds, usually from the first week of May to the first of June. Our collection period in the coastal bays in 2007 indicated hat seeds were available for harvest through mid-June, although the initial collection date was late May. As our observations have indicated that floating seeds are available for a much briefer period (perhaps a week at most), our major efforts will be to continue our previous protocols of hand harvesting reproductive shoots with mature seeds when they become available until the time when our observations indicate that most seeds have been released by the plants. Our past efforts have usually been completed by June 10. In 2005, we developed a portable mechanical harvester with funds provided by the Army Corps of Engineers which allowed us to harvest plants with fewer people and reduced costs. These methods will be used again in 2009 where feasible. Harvested reproductive shoots are returned to the VIMS laboratory and placed in large seawater holding tanks at the SAV greenhouse. These are monitored for seed release and when completed, seed are separated from all detritus and plant material and held until the period when seeds are broadcast. The maximum yield from our hand harvest and mechanical collections has been 10 million seeds. However, as flowering shoot densities vary each year, we have generally averaged between 3 and 4 million seeds. Our goal for seed collection efforts in 2009 will be 10 million seeds.

GOAL 2 Partnerships with conservancy and bay state management groups.

* Work collaboratively with Bay conservancy groups such as the Chesapeake Bay Foundation (CBF), Coastal Conservation Association (CCA), Alliance for Chesapeake

Bay (ACB) and The Nature Conservancy (TNC) among others, to assist and enhance baywide SAV restoration efforts.

Many conservancy groups are conducting restoration projects on their own, utilizing lessons learned via our work with this project. The future of SAV restoration baywide will require both the ability to grow SAV in an aquaculture setting, so that wild beds remain undisturbed, but also to utilize existing beds as a seed source as we are currently doing for eelgrass seeds.

We will also continue to assist conservancy groups with their restoration efforts by providing technical advice and training sessions as requested and by inviting these groups to help us in our projects, including seed collections in the late spring. Our objective is to develop unique partnerships between scientists, educators, and the general public to restore bay grasses where possible. This effort will span a range of areas from high salinity sites in the lower bay to lower salinity sites where many SAV water species historically dominated the shallows.

PRODUCTS

Quarterly reports will be submitted to VMRC outlining progress and results to date for that quarter as well as planned activities for the next quarter. Reports will be due as required by VMRC. In lieu of a final report, we will continue to analyze data and write papers in a publishable format and submit these to peer review journals. We will also make presentations at scientific meetings as well as general public meetings as requested.

TIMELINE

	2009							2010				
TASK	J	J	A	S	O	N	D	J	F	M	A	M
Collect and Maintain Seeds	X	X	X	X								X
Disperse Seeds				X	X	X						
Monitor Transplants	X	X			X	X					X	X
Data Analysis			X				X	X	X	X		
Quarterly Reports				X				X			X	

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Figure 1. Overview map of eelgrass restoration sites in the Virginia coastal bays.

Figure 2. Diagram of plots seeded in Hog Island Bay between 2006 and 2008. Natural recruitment of eelgrass (not derived from restoration efforts in Hog Island Bay, but possibly established from floating reproductive shoots from restored plots in nearby bays), indicated in red outline, was discovered after distribution of 2006 plots.

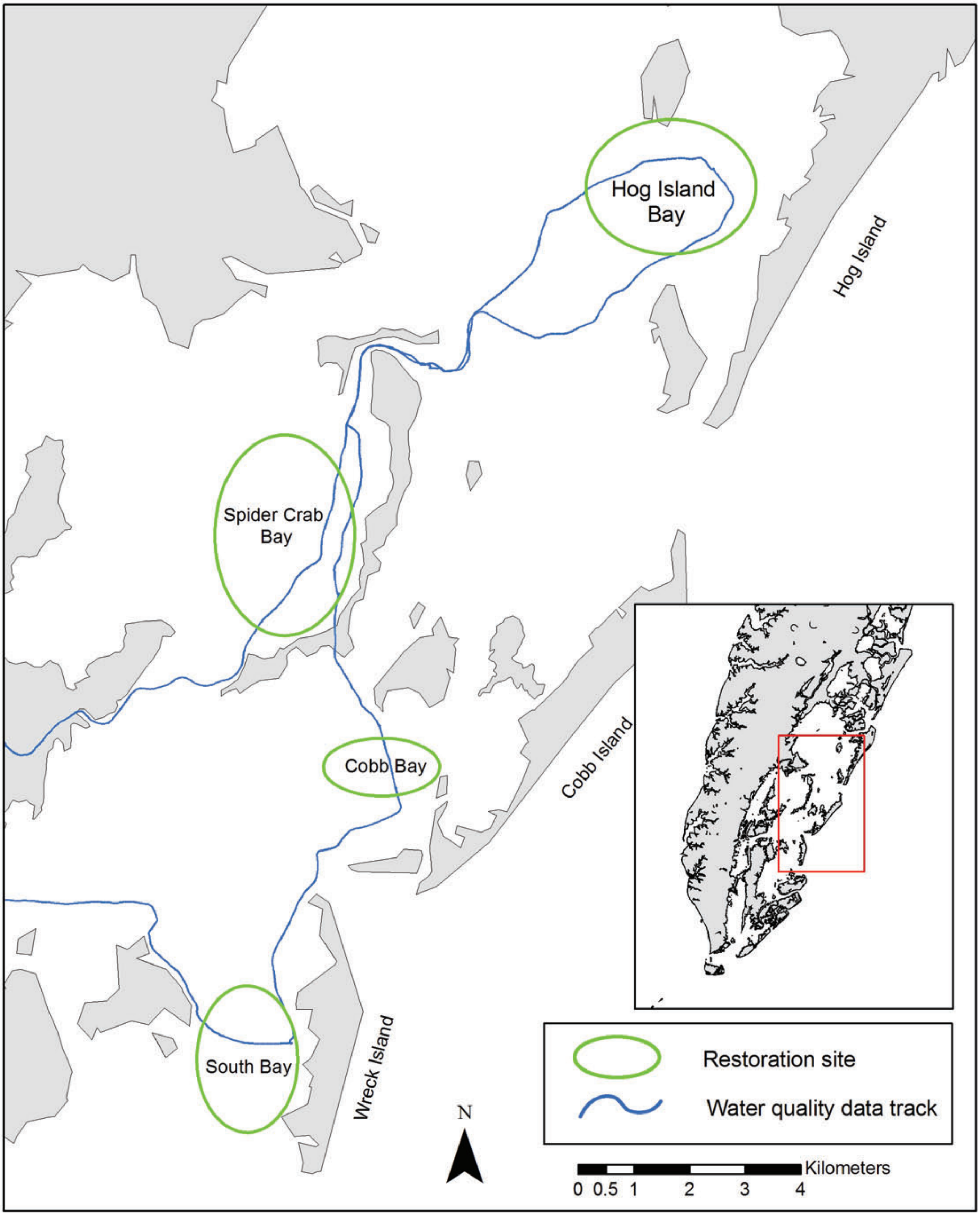
Figure 3. Restoration trajectories from the Virginia Coastal Bays measured by three metrics: (1) Cumulative area seeded with eelgrass between 1998 and 2008; (2) Area mapped by an annual seagrass monitoring program each year through 2007, incorporating the entire polygon area surrounding restored plots; (3) Area of bottom cover through 2007, the estimated area of eelgrass canopy cover calculated from the weighted sum of areas in four cover classes assigned during mapping.

Figure 4. Sequence of aerial photographs of the South Bay restoration site for 2002-2008. One-acre plots distributed in 2001 are faintly visible as dark squares by 2002. Consolidation of plots is visible as a dark region along the east side of the bay in 2006. By 2008, the entire area between plots had consolidated into a largely continuous-cover meadow of over 750 acres.

Figure 5. Color aerial photograph of the Cobb Bay restoration site in 2008, showing regional spread of eelgrass from restored plots into the surrounding area.

Figure 6. Color aerial photographs of the Spider Crab Bay restoration site in 2008. (a) Early-stage development of 0.5-acre plots broadcast between 2004 and 2007, and test strips established by an experimental seed injection machine in 2006. (b) Regional spread of eelgrass nearby circular plots established in 2003.

Figure 1



Hog Island Bay
Hog Island
Spider Crab Bay
Cobb Bay
Cobb Island
South Bay
Wreck Island
Restoration site
Water quality data track
N
Kilometers
0 0.5 1 2 3 4

Figure 2

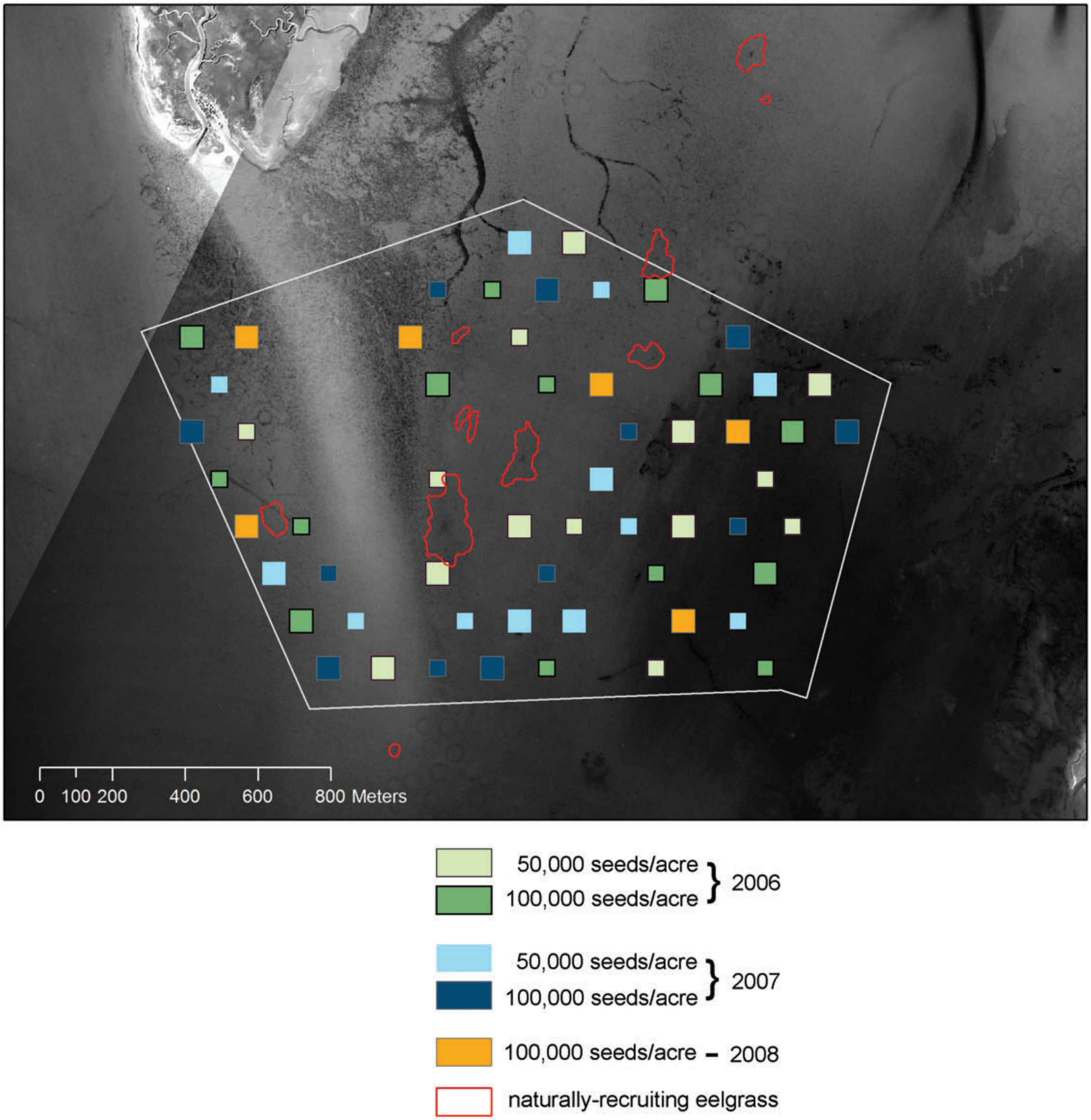
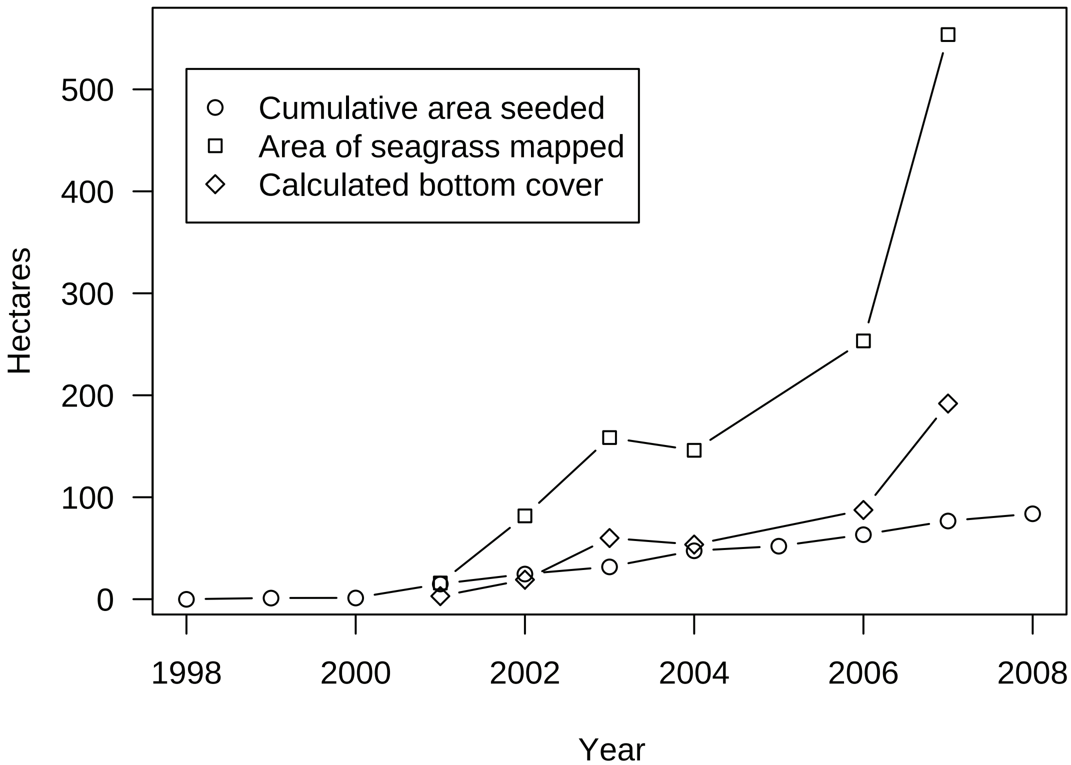

0 100 200 400 600 800 Meters
50,000 seeds/acre
100,000 seeds/acre
2006
50,000 seeds/acre
100,000 seeds/acre
2007
100,000 seeds/acre – 2008
naturally-recruiting eelgrass

Figure 3



Cumulative area seeded
Area of seagrass mapped
Calculated bottom cover
Hectares
0
100
200
300
400
500
1998
2000
2002
2004
2006
2008
Year

Figure 4

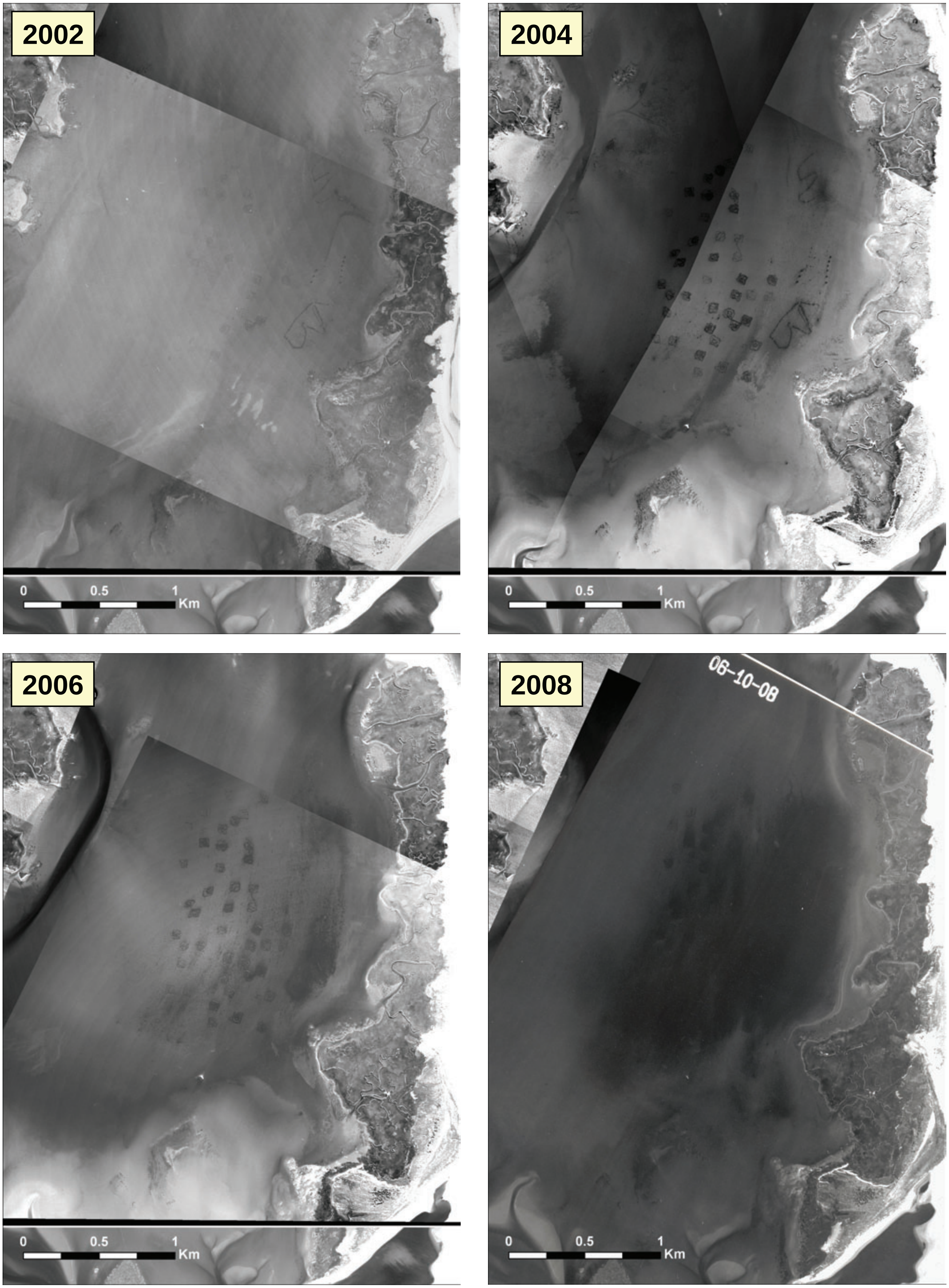


Figure 5

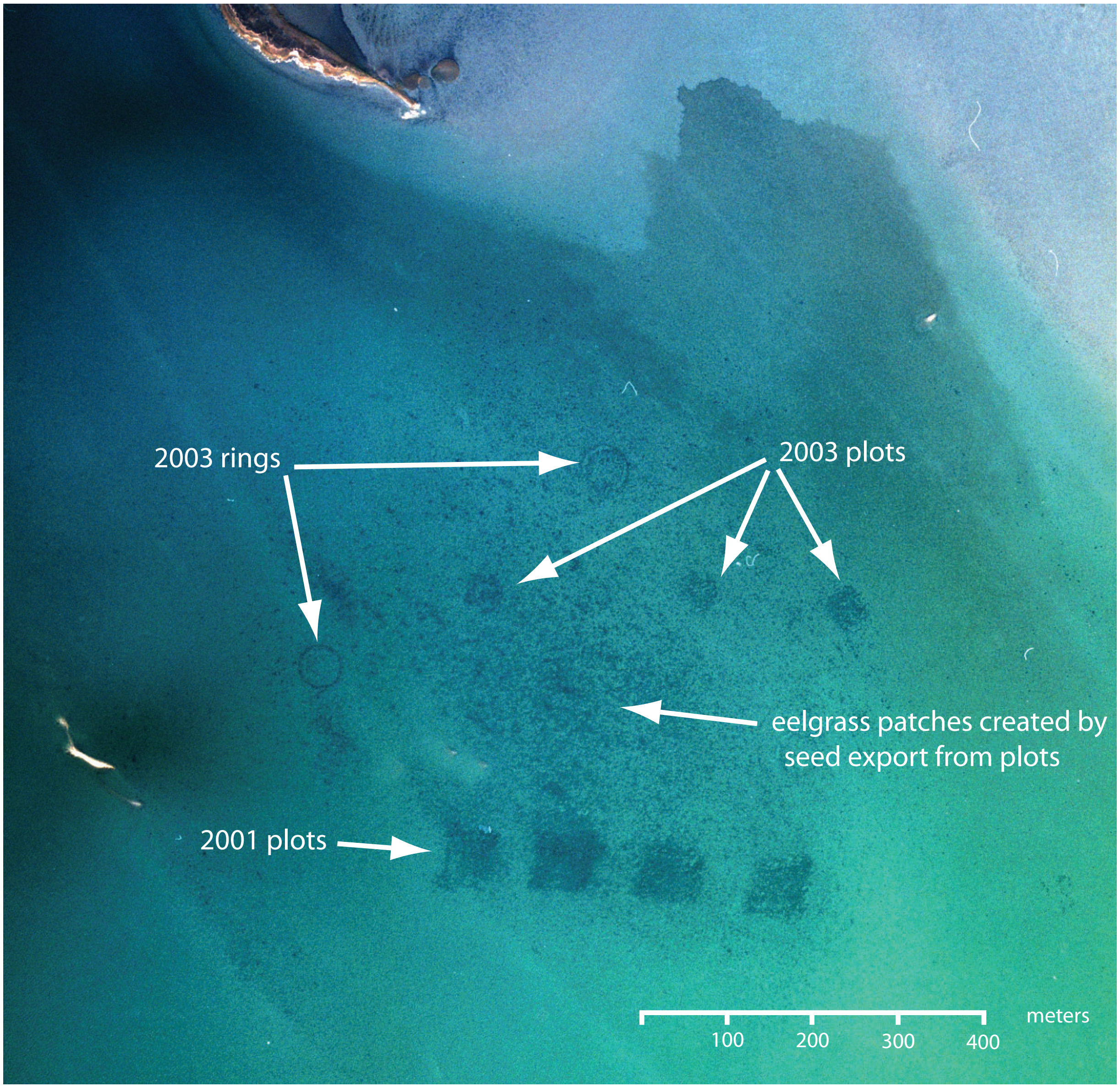
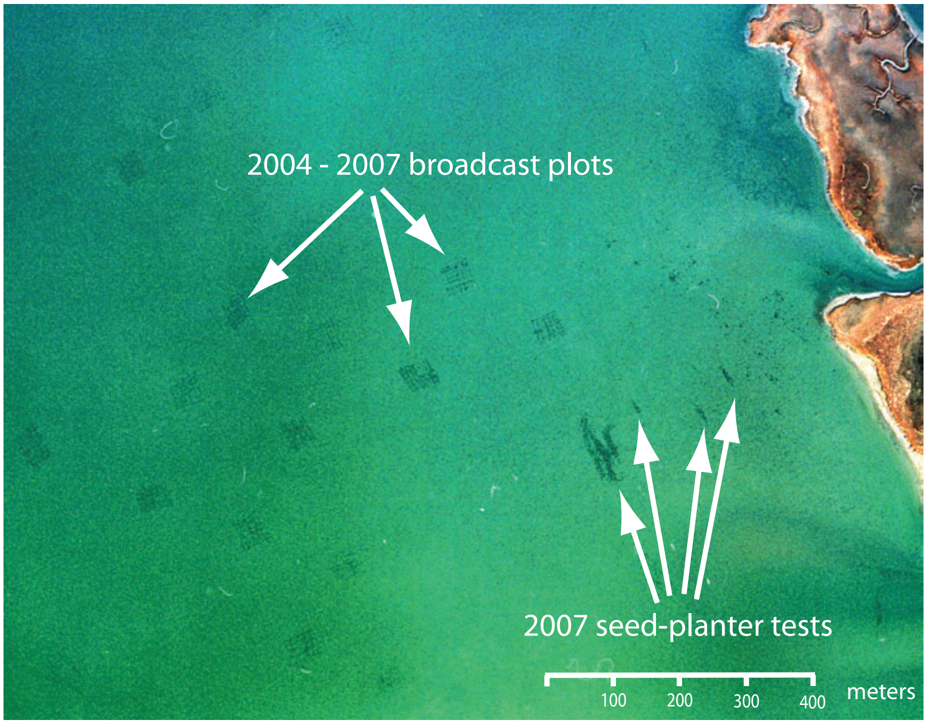
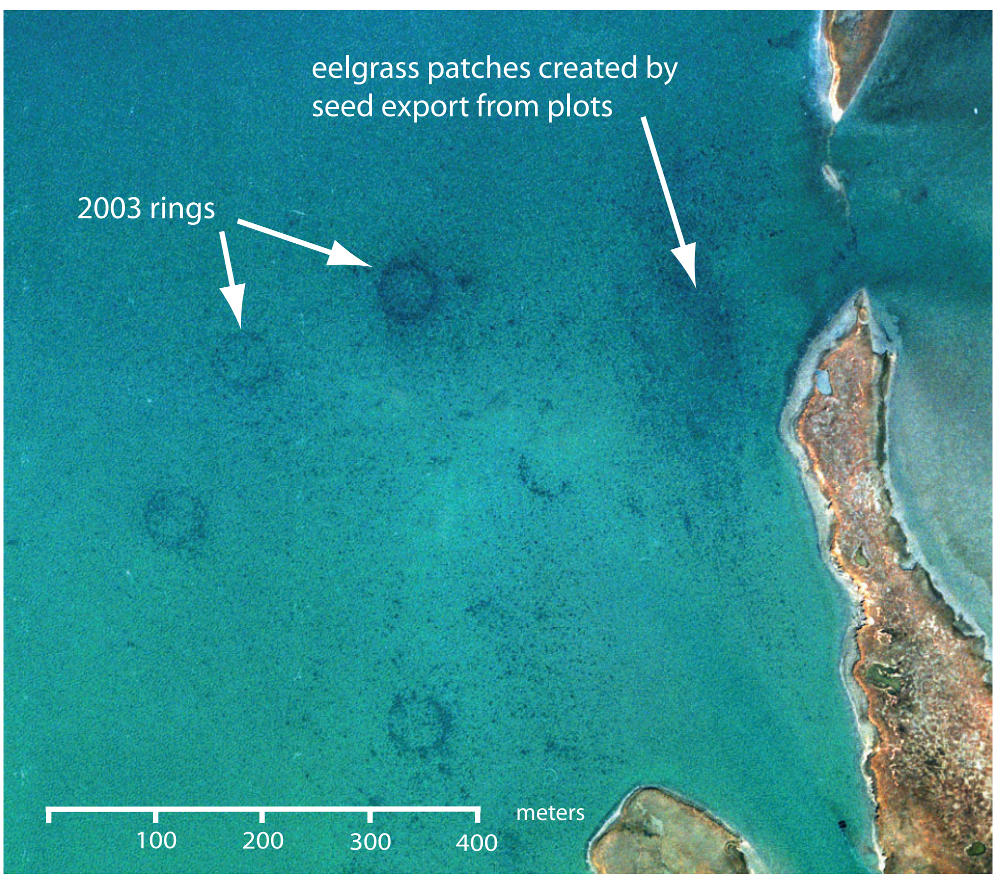

2003 rings
2003 plots
eelgrass patches created by
seed export from plots
2001 plots
meters
100
200
300
400

Figure 6

a)


2004 - 2007 broadcast plots
2007 seed-planter tests
100
200
300
400
meters

b)


eelgrass patches created by
seed export from plots
2003 rings
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